Author: **Joseph Rasson** | Department: **Mechanical Engineering** | Date: **14 October, 2002**

APPENDIX B

Request for Proposal XXXXX

DRAFT

Statement Of Work

LHC Cryogenic Distribution Boxes Fabrication, Assembly, Test, and Shipping

Submitted by: **DFBX Engineering Group**

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1 General Information

The US LHC Accelerator Project will provide eight cryogenic distribution boxes (DFBX) to CERN for the Large Hadron Collider in Geneva, Switzerland. These distribution boxes connect the super conducting magnets built by Fermi National Accelerator Laboratory (Fermilab) and Brookhaven National Laboratory (BNL) to the LHC cryogenics, high-current DC power, and instrumentation systems. Lawrence Berkeley National Laboratory (LBNL) is responsible for the design and fabrication of the distribution boxes.

A total of eight distribution boxes will be fabricated. All boxes are of similar design and complexity but vary slightly from each other depending on their location in the LHC ring. Two pairs of boxes are identical to each other other, accounting for six different variants of the design. The major difference is in cases when the boxes are not connected to super conducting magnets on one end, and fewer cryogenic pipes are required. Top-level assembly drawings sheets 2 and 3 serve to illustrate the configuration of the assembled feedboxes and indicate the degree of variation in design details and complexity over the six types.

Table 1 and the top-level assembly drawings summarize the design variations among the eight distribution boxes. Each box is located on the left or right side of one of the four crossing “Interaction Regions” (IR) of the LHC (IR1, 2,5, and 8), and is given a unique designation according to its location. Table 1 shows the location, designation and assembly drawing number for each feedbox. Note that DFBX-G and DFBX-H (IR8) are identical to and follow the same assembly drawings as DFBX-C and DFBX-D (IR2) respectively. The complete list of drawings and bill of material for each box is given in Attachment xx.

The top-level assembly drawings show the general configuration of each box and its internal piping. One end connects to the super conducting quadrupole magnet in all 8 cases. The opposite end connects to a super conducting dipole magnet in four of the boxes and a warm to cold transition with only a warm vacuum beam pipe extending from it in the other four locations. The two jumpers extending from the top of the box connect to the LHC cryogenic transfer line. The jumpers are always pointing away from the center of the ring regardless of location. The assembled feedboxes include power leads rated at 7.5 kA, utilizing high temperature superconductor (four in each of four of the boxes and six in each of the other four), and four assemblies of conventional vapor cooled power leads rated at 600 A or 120 A. The power leads extend upwards from the liquid helium vessel in two rows; the HTS leads are always on the side opposite the connection to the cryogenic transfer line.

All leads will be purchased separately by LBNL for integration by the fabricator into the feedboxes. LBNL will also provide other specialized components, such as internal instrumentation, the magnet power bus duct assemblies (MQX1 and MBX1), magnet

instrumentation ducts (MQX2 and MBX2), and jacketed bore tubes. A complete list of equipment provided by LBNL to the manufacture for assembly into the feed boxes is given in Attachment xx

Table 1. Design summary of eight DFBXs.

Location	Designation	Assembly Drawing	Features
IR1 Left	DFBXA	24C351	Cryogenic and electrical services for super conducting quadrupole magnet extend from one end. The pipes exiting from this end are the same for DFBXA, DFBXC, DFBXF and DFBXG. There are slight differences in the internal routing of the pipes. The other end has a cold to warm transition and only one warm vacuum beam pipe extending from it and is otherwise sealed. Contains four 7.5 kA high temperature super conducting (HTS) power leads.
IR1 Right	DFBXB	24C350	Cryogenic and electrical services for super conducting quadrupole magnet extend from one end. The pipes exiting from this end are the same for DFBXB, DFBXD, DFBXE and DFBXH. There are slight differences in the internal routing of the pipes. The other end has a cold to warm transition and only one warm vacuum beam pipe extending from it and is otherwise sealed. Contains four 7.5 kA high temperature super conducting (HTS) power leads.
IR2 Left	DFBXC	24C352	Cryogenic and electrical services for super conducting quadrupole magnet extend from one end. The pipes exiting from this end are the same for DFBXA, DFBXC, DFBXF and DFBXG. There are slight differences in the internal routing of the pipes. The other end has cryogenic and electrical services for a superconducing dipole magnet. Contains six 7.5 kA high temperature super conducting (HTS) power leads. DFBXC is identical to DFBXG.
IR2 Right	DFBXD	24C362	Cryogenic and electrical services for super conducting quadrupole magnet extend from one end. The pipes exiting from this end are the same for DFBXB, DFBXD, DFBXE and DFBXH. There are slight differences in the internal routing of the pipes. The other end has cryogenic and electrical services for a superconducing dipole magnet. Contains six 7.5 kA high temperature super conducting (HTS) power leads. DFBXD is identical to DFBXH.
IR5 Left	DFBXE	24C394	Cryogenic and electrical services for super conducting quadrupole extend from one end. The pipes exiting from this end are the same for DFBXB, DFBXD, DFBXE and DFBXH. There are slight differences in the internal routing of the pipes. The other end has a cold to warm transition and only one warm vacuum beam pipe extending from it and is otherwise sealed. Contains four 7.5 kA high temperature super conducting (HTS) power leads.

IR5 Right	DFBXF	24C395	Cryogenic and electrical services for super conducting quadrupole extend from one end. The pipes exiting from this end are the same for DFBXA, DFBXC, DFBXF and DFBXG. There are slight differences in the internal routing of the pipes. The other end has a cold to warm transition and only one warm vacuum beam pipe extending from it and is otherwise sealed. Contains four 7.5 kA high temperature super conducting (HTS) power leads.
IR8 Left	DFBXG	24C352	Identical to DFBXC
IR8 Right	DFBXH	24C362	Identical to DFBXD

2 Scope of Work

The following list details the scope of work to be performed by the Subcontractor:

2.1 The work scope included herein is for the fabrication, assembly and test of eight cryogenic distribution boxes in accordance with this Statement of Work.

2.2 Cryogenic distribution boxes shall delivered FOB destination CERN (Switzerland) receiving dock. The final acceptance tests shall be performed at CERN.

2.3 Subcontractor shall be responsible for packing and shipping to CERN from the Subcontractor's facility in accordance with the Shipping Specification document presented in Attachment xx. The Berkeley Lab will cover any import duties and costoms if applicable.

2.4 The cryogenic distribution-boxes delivery schedule shall be in accordance with the delivery schedule submitted by the Subcontractor's proposal in response to this RFP.

2.5 Subcontractor shall procure/fabricate all materials and hardware required to perform the work listed in this Statement of Work, with exception of those parts listed as Government Furnished Material (GFM)

2.6 Subcontractor may start procurement of material and fabrication of components for all eight distribution boxes simultaneously if deemed to be necessary to meet production schedule and provide best value to the Berkley Lab.

2.7 Subcontractor shall incorporate the GFM into the assembled distribution boxes in accordance with their assembly specifications.

2.8 Subcontractor shall provide all necessary tooling, fixtures, instruments and cryogen needed during the assembly, handling, tests and acceptance procedures.

3 List of Deliverables:

3.1 Eight Manufactured and assembled cryogenic distribution boxes in accordance with this Statement of Work Document
Delivery is FOB: Destination, Geneva, Switzerland to the following address:
CERN
CH-1211
Geneva, Switzerland
Att. Ranko Ostojic

3.2 All hardware or tools specifically designed, fabricated or procured by the subcontractor to perform the acceptance tests listed in LBNL Specification M989, Attachment xxx. Tools required to perform acceptance tests after shipping to CERN shall be delivered along with the distribution boxes. All

other tooling and fixtures shall be delivered no later than 90 days from the delivery date of the last (8) distribution box.

3.3 Packing and shipping material and/or containers used to transport the equipment to CERN in accordance with Shipping Specification Document LBNL M986, Attachment xx

3.4 Certified mill test reports of all materials used to fabricate deliverables shall be provided to Berkeley Lab prior to final acceptance. The certifications shall include all processes and tests including 4K Charpy Impact test for parent and weld material.

3.5 Certification of all key welding personnel and equipment that will perform any welding task on the deliverables. All certifications shall be current and up to date with all applicable codes and standards.

3.6 Completed traveler forms listed in Acceptance Specification M989, Attachment xxx and any exception reports generated by the Subcontractor during the fabrication and assembly of the components.

3.7 All inspection and test data generated by the Subcontractor during the fabrication and assembly of components and systems

3.8 All engineering design data generated by the Subcontractor including any as- built drawings in CAD readable electronic format and paper prints or red-lined LBNL drawings.

3.9 Subcontractor shall submit monthly progress report to LBNL Procurement Specialist. Reports shall include technical status and schedule update.

3.10 Subcontractor shall submit monthly progress report to LBNL Procurement Specialist. Reports shall include technical status and schedule update

4 Post Award Conference

A post award conference will be held to address the concerns of the Subcontractor and the Berkeley Lab, review the fabrication and assembly plan, and to coordinate the delivery schedule of the Government Furnished Material (GFM). This meeting will be held at the Subcontractor's facility no later than 2 months after the Contract is awarded.

Specific Discussion Items at the Post Award Conference:

4.1 Any inconsistencies, errors, or omission in the Berkeley Lab provided drawings or documents

4.2 Final mechanical fabrication and assembly plan

4.3 Power leads installation procedures

4.4 Bus duct installation procedures

4.5 Instrumentation conduits installation procedures

4.6 Cryogenic sensors installation procedures

4.7 MLI fabrication and assembly plan

4.8 Schedule for GFM integration into the assemblies
4.9 Subcontractor's inspection and QC plan
4.10 Subcontractor's vacuum leak check procedures
4.11 Assembly and Shipping plan and schedule

5 Conferences, Meetings and Reporting

5.1 Subcontractor shall host a four-hour status meeting once a month at the subcontractor facility to allow LBNL representative review progress. These meetings shall be attended by the Subcontractor's Project Manger responsible for this project.

5.2 Subcontractor shall hold a one hour telephone conference meeting once a week with LBNL representative to provide project status.

5.3 Subcontractor shall submit monthly progress report to LBNL Procurement Specialist. Reports shall include technical status and schedule update.

6 Fabrication Requirements

6.1 General Requirements:

The cryogenic distribution boxes shall be fabricated and assembled to the dimensions and instructions detailed in the fabrication drawing package. The subcontract shall develop the fabrication and assembly processes that meet the design intent and offer best value to the Berkeley Laboratory.

6.2 Piping Assemblies:

6.2.1 Subcontractor shall fabricate piping and process components in accordance with the American Standards Institute B.31.5, Refrigeration Piping

6.2.2 Subcontractor shall attach a "pressure-tested" label to pipe ends to identify that the pressure acceptance test is completed.

6.2.3 Subcontractor shall substitute fittings for tube bends as needed with LBNL approval.

6.2.4 Subcontractor shall consider alternate welding preps with LBNL approval.

6.2.5 Subcontractor shall select the type of ends on the flex hoses. In locations where flex hose ends are specified on the LBNL fabrication drawings, the Subcontractor shall specify alternate ends with LBNL approval.

6.2.6 Subcontractor shall substitute tubes with pipes or vice-versa with LBNL approval as long as the following conditions are met:

6.2.6.1 Tube O.D and I.D exiting the DFBX (interfaces to other equipment) are unchanged from what stated in the fabrication drawings.

6.2.6.2 Minimum flow cross section area is maintained as stated in the fabrication drawings.

6.2.6.3 Minimum clearance between pipe assemblies is greater than 1.0" after installation.

6.2.7 Subcontractor shall select alternate pipe routings with LBNL approval as long as the following conditions are met:

6.2.7.1 Pipe positions at the ends are unchanged

6.2.7.2 The Subcontractor shall demonstrate a minimum allowance of 1.0 inch for thermal contraction.

6.2.7.3 Pipe supports are unchanged from what is shown in the fabrication drawings.

6.3 Thermal Shield:

6.3.1 Subcontractor shall consider alternate method subject to LBNL approval to fasten the thermal shield panels to one another as long as good thermal contact is maintained

6.3.2 Subcontractor shall consider alternate method to anchor the trace cooling tubes to the thermal shield subject to LBNL approval as long as allowance for the differential thermal contraction is taken into account and adequate thermal contact is maintained.

6.4 Multi Layer Insulation (MLI):

6.4.1 Multi Layer Insulation (MLI) is specified in LBNL Specification M-990 and is included in Attachment xxxxxi.

6.4.2 Subcontractor shall consider alternate MLI material or alternate method of application subject to LBNL approval.

6.4.3 For safety reasons there shall be a minimum of 10 layers of MLI applied to the liquid helium vessel.

6.5 Helium Vessel:

6.5.1 The helium tank and lead chimneys shall be fabricated in accordance to the standards of the ASME Pressure Vessel Code, Section 8.

6.5.2 All welds in the helium tank assembly must be made in accordance to the ASME Pressure Vessel Code with the exception of the close out weld of the access panel.

6.5.3 All longitudinal welds in the helium tank except for the tank door welds must be radiographed. The radiographs and their interpretation must be included as part of the traveler as required by the Acceptance Specification No. LBNL M-989.

6.5.4 Root pass and cover pass welds for the tank access panel shall be inspected for cracks using a dye penetrant test as required by the Acceptance Specification No. LBNL M-989.

6.5.5 The Subcontractor shall notify the Berkeley Lab of the pressure test date at least two weeks in advance to allow a representative of LBNL to witness the pressure test.

6.5.6 After the helium vessel passes the witnessed pressure test, the Berkeley Lab will provide a metal tag identifying the helium vessel as a Berkeley Lab tested pressure vessel. The tag shall be affixed to the outside surface of the vacuum vessel as specified in the top-level assembly drawings.

6.6 Bus Duct Installation:

6.6.1 The bus duct and lambda plate assemblies, MQX1 and MBX1 shall be fabricated and tested at LBNL.

6.6.2 The ends of the bus duct shall be capped to protect the power conductor and shipped to the Subcontractor along with the installation instruction.

6.6.3 The Subcontractor shall notify the Berkeley Lab of the installation date at least two weeks in advance to allow a representative of LBNL to witness the bus duct installation.

6.7 Magnet Instrumentation Conduits:

6.7.1 The magnet instrumentation conduits, MQX2 and MBX2 shall be fabricated and tested at LBNL.

6.7.2 The ends of the conduits shall be capped to protect the wires and shipped to the Subcontractor along with the installation instruction.

6.7.3 The Subcontractor shall notify the Berkeley Lab of the installation date at least two weeks in advance to allow a representative of LBNL to witness the conduit installation.

6.8 Beam Tube:

6.8.1 The beam tube and its cooling jacket shall be fabricated and tested at LBNL.

6.8.2 The beam tube shall be shipped to the Subcontractor with its ends capped.

6.8.3 The Subcontractor shall install the beam tube in the feedbox and make the final connection between the beam tube cooling jacket and the LD pipe in accordance with drawing numbers 25I206, 25I210 and 25I 252

6.9 Cryogenic Instrumentations:

6.9.1 Cryogenic instrumentations such as temperature sensors to determine the thermodynamic performance of the feedbox during operation shall be supplied to the Subcontractor by the Berkeley Lab.

6.9.2 The Subcontractor shall install the sensor per installation procedures specified on the fabrication drawings.

6.10 Current Leads Installation and Splice Procedure:

6.10.1 The HTS leads along with their handling fixture will be delivered to the Subcontractor after they pass acceptance tests at FNAL.

6.10.2 Vapor cooled leads will be shipped directly from the vapor cooled lead manufacturer to the Subcontractor after they pass the acceptance test at the lead manufacturer.

6.10.3 The leads handling and installation instructions will be provided to the Subcontractor at the time of the lead delivery.

6.10.4 Current lead splice procedures shall be performed in accordance to Specifications No. M982, M983 and M985.

6.10.5 Subcontractor shall notify the Berkeley Lab at least 10 days prior to starting the splice operation to allow for representatives from LBNL to witness the splice operation at the Subcontractor's facility.

6.10.6 Subcontractor shall provide a test sample of each type of splice to Berkeley Lab prior to performing the splice operation in the feedbox to demonstrate that the splice parameters are properly set.

6.11 Vacuum Vessel:

6.11.1 The vacuum vessel shall provide vacuum containment for all the internal components and support the weight and dynamic loads inside the DFBX since positions of the internal components are directly coupled to the position and straightness of the vacuum vessel.

6.11.2 Warpage of the vacuum vessel top plate during final weld operation in excess of the value stated in the Acceptance Specification LBNL M-989 may cause the lead chimneys and the helium vessel to deviate from the tolerances specified in the fabrication drawings.

6.11.3 Upon submission of a proposal or bid to the Berkeley Lab, Subcontractor shall describe in details the vacuum vessel fabrication and weld plan that meets the requirement set in the Acceptance Specification No. LBNL M-989.

6.11.4 Weld rings where the chimneys are welded to the top plate shall be utilized by the Subcontractor to reposition the chimneys after welding the vacuum vessel plates to meet the requirement set in the Acceptance Specification No. LBNL M-989.

6.12 Part Cleaning, Identification and Storage:

6.12.1 Subcontractor shall submit their cleaning procedure upon submission of a proposal or bid to the Berkeley Lab for approval.

6.12.2 All final cleaning procedures must be in accordance with the Berkeley Lab approved cleaning procedures.

6.12.3 The inside of pipes shall be cleaned and capped prior to use in the fabrication.

6.12.4 Cutting fluids, metal chips, dye penetrant materials, and all other extraneous material shall be removed as components are fabricated.

6.12.5 MLI shall be protected during assembly. No fingerprints, oil or dust shall be allowed to remain on any surface of the MLI.

6.12.6 Only vacuum-compatible anti-seize compound shall be used on the assembly of components located in the vacuum space.

6.12.7 The Copper thermal shield shall be cleaned to a bright metal condition.

6.12.8 After parts or subassemblies are completed they should be bagged and properly stored to protect cleanliness and dimensional integrity.

6.12.9 Parts must be tagged with drawing numbers.

6.13 Welding, Weld inspection and Weld Repair

6.13.1 Subcontractor shall submit their welding specifications upon submission of a proposal or bid to the Berkeley Lab for approval.

6.13.2 All welding shall be performed in accordance with applicable codes and standards.

6.13.3 The Subcontractor shall possess the ASME "U" Stamp and shall perform the work in accordance with the ASME Boiler and Pressure Vessel Code and the American Welding Society. However, the DFBX will not be "U" stamped.

6.13.4 All welds including temporary welds shall be performed by qualified and ASME certified welders.

6.13.5 Distortion of welded parts shall be minimized and in accordance with the requirements stated in the Acceptance Specification LBNL M989, Attachment XXX.

6.13.6 Copper thermal shield joining shall be performed with Inert Gas Shielding or suitable fluxes such that the thermal conductivity or mechanical strength is unchanged from values specified in the material certifications.

6.13.7 The Subcontractor shall insure that weld metals are procured, stored and used in accordance with applicable requirements of AWS. 4K Charpy Impact tests shall be carried out to qualify helium vessel base metal, welded metal, and weld procedure.

6.13.8 All welds shall be inspected by qualified inspectors and in accordance with applicable requirements of AWS QC1 and the DFBX Acceptance Specification LBNL M-989, Attachment xxx.

6.13.9 All weld areas containing defects exceeding the standards of acceptance in AWS shall be repaired with applicable requirements of AWS D1.1.

6.14 Part Repair

6.14.1 Repairs to any part of the DFBX during the fabrication or assembly process requiring welding, soldering, or brazing of any sort shall be pre-approved by LBNL.

6.14.2 Pipes shall not be bent to achieve position tolerances after completing the pipe vacuum leak test.

6.14.3 If such a repair needs to be done, the Subcontractor shall submit to LBNL a description of the problem and the location, the repair to be done, and the proposed methodology to be used for approval by LBNL

6.15 Marking and Traceability

6.15.1 Subcontractor shall inscribe parts with identifiable and traceable markings. These are to be recorded by manufacturer. Sufficient information shall be recorded as to trace materials, process and any possible Subcontractor's work.

6.15.2 Subcontractor shall permanently affix nameplate provided by the Berkeley Lab for each DFBX.

6.16 Notification

6.16.1 In the event that the Subcontractor detects a mistake in the drawing, machining or fabrication of the parts listed herein, the Subcontractor shall notify Berkeley Lab within 24 hours. Berkeley Lab will have 72 hours, excluding weekends and official holidays, to respond to such notification without incurring any costs due to idle equipment, manpower, or temporary storage space.

6.16.2 Subcontractor must notify LBNL at least 10 working days ahead of the date the following activities will be performed:

- 6.16.2.1 Installation of the bus ducts MQX1 and MBX1
- 6.16.2.2 Installation of magnet power leads
- 6.16.2.3 Splicing of magnet cables
- 6.16.2.4 Hi pot test in air of the magnet conductors
- 6.16.2.5 Helium vessel pressure test
- 6.16.2.6 Hi pot test in He of magnet conductor
- 6.16.2.7 Installation of the instrumentation conduits MQX2 and MBX2

6.16.2.8 Hi pot test in air of instrumentation wires in air
6.16.2.9 Wrapping the helium vessel and lead chimneys with MLI
6.16.2.10 Welding of vacuum vessel plates
6.16.2.11 Final vacuum tests of all pipes and helium vessel after completing the vacuum vessel welds
6.16.2.12 Final dimensional checks of all pipes and flanges
6.16.2.13 Placing the DFBX in its shipping crate.
6.16.2.14 Shipping the DFBX.

7 Applicable Documents

7.1 The following documents and documents referenced therein form a part of this Statement of Work to the extent specified herein.

7.2 In the event of a conflict between the referenced documents and the contents of this specification the Subcontractor shall immediately notify the Berkeley Lab for clarification before completing the proposal or proceeding with work on the affected part.

7.3 No substitution or deviation from these drawing and specifications maybe made without written authorization from the Berkeley Lab procurement representative.

7.3.1 Acceptance Specification LBNL-989
7.3.2 Crating and Shipping Specification LBNL-XX
7.3.3 HTS Lead Splice Specification LBNL-M985xx
7.3.4 120 Amp Vapor Cooled Lead Splice Specification LBNL-M981xx
7.3.5 600 Amp Vapor Cooled Lead Splice Specification LBNL-M983xx
7.3.6 MLI Application Specification LBNL M-990
7.3.7 Cryogenic Distribution Box Flow Schematics:
7.3.7.1 The feedboxes flow schematics for all 8 feedboxes are provided in drawing number 24C370 (sheets 1 through 4) in Attachment xx.
7.3.7.2 The flow Schematics specifies the DFBX cryogenic connections to the super conducting magnets and the CERN's cryogenic distribution system.
7.3.7.3 The feedbox flow schematic and mechanical are in accordance with the functional and interface requirements of the feedboxes.
7.3.8 Drawing Package and Bill of Material
7.3.8.1 Attachment xx includes a set of size B engineering drawings fully describing requirements for the fabrication of DFBX-G and DFBX-C.
7.3.8.2 The drawing package consists of the Bill of Material (BOM), top-level assembly drawings and part drawings.

7.3.8.3 The top-level assembly drawings of the 5 other configurations in a preliminary format with the exception of the piping packages are presented in Attachment XX

7.3.8.4 The piping subassemblies detailed fabrication drawings for the remaining five configurations shall be released to the bidders four weeks prior to the bid response date requested in this RFP. The piping subassemblies for all other configurations are based on the attached flow schematics drawing No. 24C370 (sheets 1 through 4) and the design approach implemented for DFBX-G and DFBX-C.

7.3.8.5 The BOM and all other unique drawings required for the fabrication of all remaining DFBX A, B, D, E and F shall be provided to the bidders four weeks prior to the bid response date requested in this RFP.

7.3.8.6 All references to Berkeley Lab design drawings in this specification refer to the latest revision of each of the drawings.

7.3.8.7 The Subcontractor shall be responsible for using the latest revision of the drawings.

7.3.8.8 For convenience, electronic files (CAD files) can be supplied by the Berkeley Lab in PDF, DXF or IGES format, but it is particularly emphasized that the supplied (paper) design drawings are the final authority as to the feature size, tolerance and locations. The Berkeley Lab is not responsible for the contents or use of the electronic files.

8 List of Government Furnished Material (GFM)

8.1 The Berkeley Lab shall supply the Subcontractor with specific components needed for the feedboxes final assembly. Attachment XXX includes the complete list of the GFM and their unit replacement cost.

8.2 The subcontractor shall assume responsibility for all material furnished by the Berkeley Lab in accordance with the Addendum to the Terms and Conditions, Article XXXX.

8.3 The GFM will be made available to the Subcontractor at least two weeks prior to their needed installation date.

8.4 Precise delivery dates of the GFM shall be discussed in the post award conference.

8.5 The GFM include the following components:

1. HTS current lead assemblies (drawing number 25I192)

2. Vapor cooled current leads assemblies (drawing numbers 24C322, 24C353 and 25I164):
3. Bus duct assemblies including busses, lambda plate and duct (drawing numbers 25M857 and 25M859)
4. Beam tube assemblies (drawing numbers 25I855, 25I510 and 25I252)
5. Interconnect bellows and welding flanges (drawing numbers)
6. Relief valve (25IXXX)
7. LHe diagnostic assembly
8. Cryogenic sensors
9. Instrumentation conduits, MQX2 and MBX2 assemblies (drawing numbers 25I301, 25I251, 25I219, 25I249
10. Vacuum vessel enclosures, seals, and clamps to be placed on the D1 flange in DFBX-A, B, E and F shown on drawing number xxxx
11. ISR jacks (drawing number 25I182)
12. Hobson tooling balls and surface plates (drawing numbers 25I868 and xxx.)
13. DFBX name and identification tags

9 Applicable Codes and Standards

The following is a list of various codes is to be applied to the design, fabrication, assembly and tests of the cryogenic distribution boxes.

1. ASME - American Society of Mechanical Engineers
   - Boiler & Pressure Vessel Code Sec VIII, Properties of Material Design Sec IID

2. ASME Y14.5M-1994 Dimensioning Tolerancing Code

3. ASTM – American Society for Testing Materials
   - Material specification
   - ASTM E-498 Standard Test Methods for Leaks Using the Mass Spectrometer Leak Detector or Residual Gas Analyzer in the Tracer Probe Mode

4. American Standards Institute B.31.5,
   - Refrigeration Piping

5. AWS – American Welding Society
   - Welding technique, testing, welder qualification and weld rod specification

6. AVS- American Vacuum Society (AVS)

- Vacuum leak check Standard. 2.1

7. ISO – International Organization for Standardization
   - For metric fasteners, threads, and flange specification

8. NEMA – National Electrical Material Association
   - Fiberglass material specification, Conductor insulation specification

9. LBNL Publication 3000
   - LBNL Health and Safety Manual available at the following URL: http://www.lbl.gov/ehs/pub3000/

10. ANSI – American National Standard Institute

11. ASA – American Standard Association
    - Material, flange, elbow, and reducer specification

12. MIL- SPEC - Military Specification
    - Peek Gasket material specification MIL-P-4681 TYPE I (NATURAL)

13 CDA – Copper Development Association
   - OFHC copper specification

14. EJMA –Expansion Joint Manufacturers Association
    - Bellow design

10 Quality Assurance

10.1 The Subcontractor shall maintain a documented quality assurance (QA) program that shall insure that each item offered for acceptance conforms to this Statement of Work.

10.2 The QA/Quality Control plan shall be submitted by the Subcontractor upon submission of a proposal or bid to the Berkeley Lab for approval.

10.3 The Subcontractor shall maintain records of all inspections and tests. In addition, the following specification shall be made available by the Subcontractor to Berkeley Lab upon submission of a proposal or bid:

10.3.1 Leak Checking Procedures
10.3.2 Welding Procedures
10.3.3 Cleaning Procedures
10.3.4 Assembly Sequence
10.3.5 Cold Shocking Procedures
10.3.6 Parts/Process/Materials Tracing Method

10.3.7 Any other Non-Destructive Test method that may be applicable to Subcontractor's Quality Control program.

10.4 Berkeley Lab reserves the right to have its technical or procurement representatives witness any or all manufacturing steps, tests and inspections established under the Subcontractor's Quality Assurance program to demonstrate compliance with this Statement of Work.

10.5 Any information of a proprietary nature must be identified in the bid process.

10.6 Berkeley Lab representative shall have visitation access to the Subcontractor's plant and personnel during normal operation hours for the purpose of conducting Quality Assurance and Audits.

10.7 Subcontractor shall provide a reasonable office space and office supplies for use the Berkeley Lab representative during the visits to Subcontractor's plant.

11 Inspection and Acceptance Requirements

11.1 The Acceptance Specification LBNL-989, Attachment XX defines the minimum required acceptance criteria, and outlines the essential dimensional checks and tests that must be performed on the cryogenic distribution boxes during fabrication and assembly.

11.2 The Subcontractor may choose to perform tests in addition to those specified in the Acceptance Specification LBNL M-989. The results of these tests must be provided to LBNL along with the DFBX acceptance traveler.

11.3 The DFBX assembly travelers must completely document all of these in process and acceptance tests so that LBNL and CERN have assurance that the appropriate measurements of tests have been satisfactory completed.

11.4 The subcontractor is to maintain a separate traveler report for each DFBX.

11.5 The final acceptance of DFBX shall take place after conforming to all the conditions specified in the Acceptance Specification LBNL M-989.

11.6 All dimensions and tolerances shown apply at reference temperature of 20 C (68 F).

11.7 The Berkeley Lab representatives or designates shall have the option to perform inspections upon the parts and assemblies to validate certain dimensions or vacuum leaks rates. Coordination of inspection visits by the Berkeley Lab or its representative will be discussed and finalized during the post award conference.

12 Packing, Shipping and Handling Requirements

12.1 Packing and shipping shall be performed in accordance with Packing and Shipping Specification LBNL M-990.

12.2 Each DFBX should be shipped with its test fixtures, any special lifting or handling fixtures and all design, fabrication and test documents.

12.3 The Subcontractor shall select the appropriate mode of transport for each DFBX as permitted by the timing of fabrication completion such that the required delivery dates are met as specified in the bidder's response to this RFP.

12.4 The Subcontractor may select to ship more than one DFBX in the same shipment as long as each DFBXs are crated separately.

12.5 Upon arrival at CERN, each DFBX must again satisfy the acceptance requirements specified in Acceptance Specification LBNL M-989.